USGS
science for a changing world

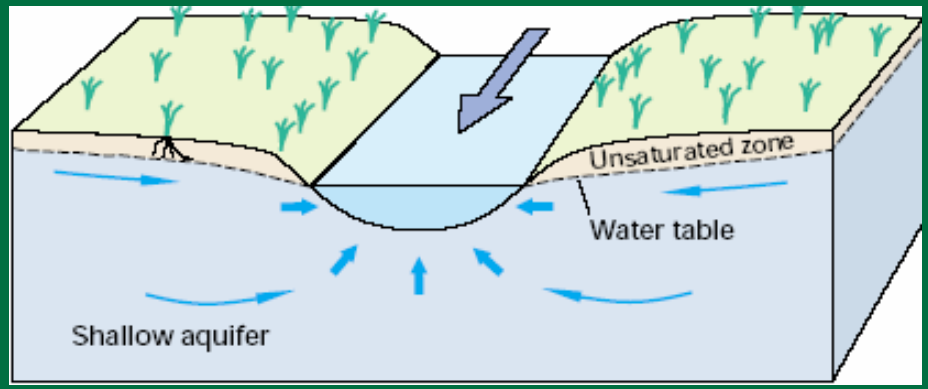
Ground-Water / Surface-Water Interaction Studies in the Spokane River Valley, ID and WA, and the Smith River Watershed, MT

Rod Caldwell
U. S. Geological Survey
Helena, Montana

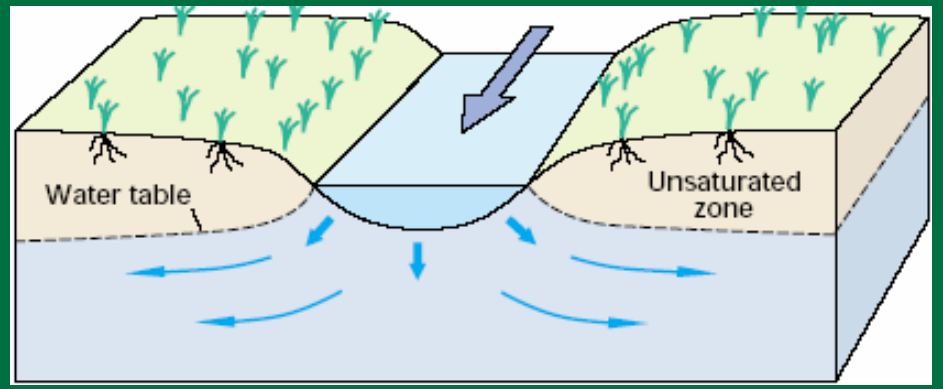
U.S. Department of the Interior
U.S. Geological Survey

Overview

- Spokane River and the Spokane Valley / Rathdrum Prairie aquifer
- Methods used in gw/sw interaction studies
- Smith River Watershed study



Gaining Reach

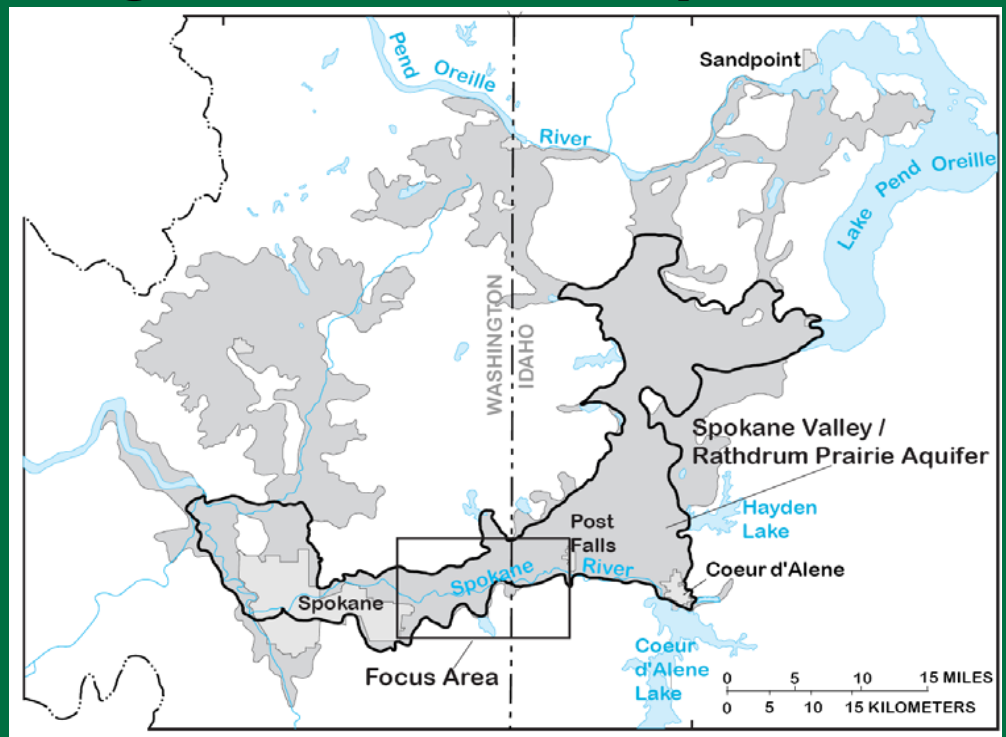


Losing Reach

USGS

Objectives - Spokane River GW/SW Study

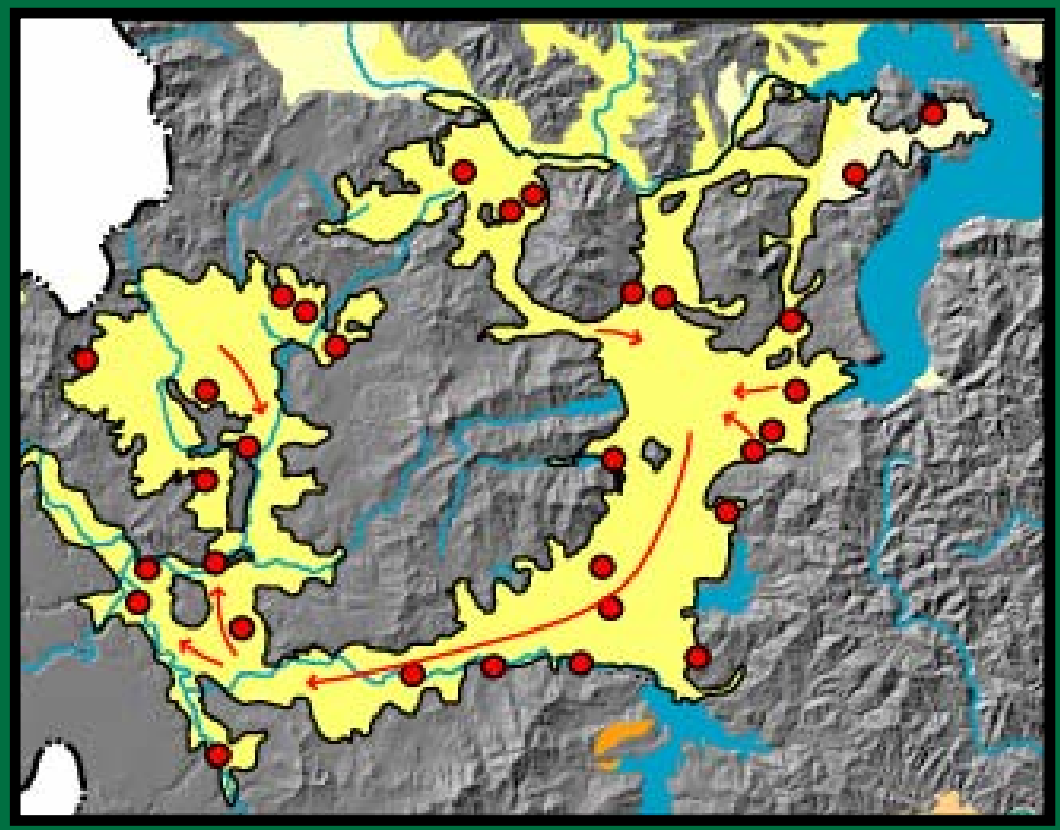
- Determine if chemical constituents in water and sediment of the Spokane River migrate into the aquifer
- Improve the understanding of GW/SW interaction along a losing reach of the Spokane River



USGS

Spokane Valley/Rathdrum Prairie Aquifer

- Sole source aquifer
- Unconfined
- High permeability
- Up to 500 feet thick
- Depth to water – a few feet to over 400 feet



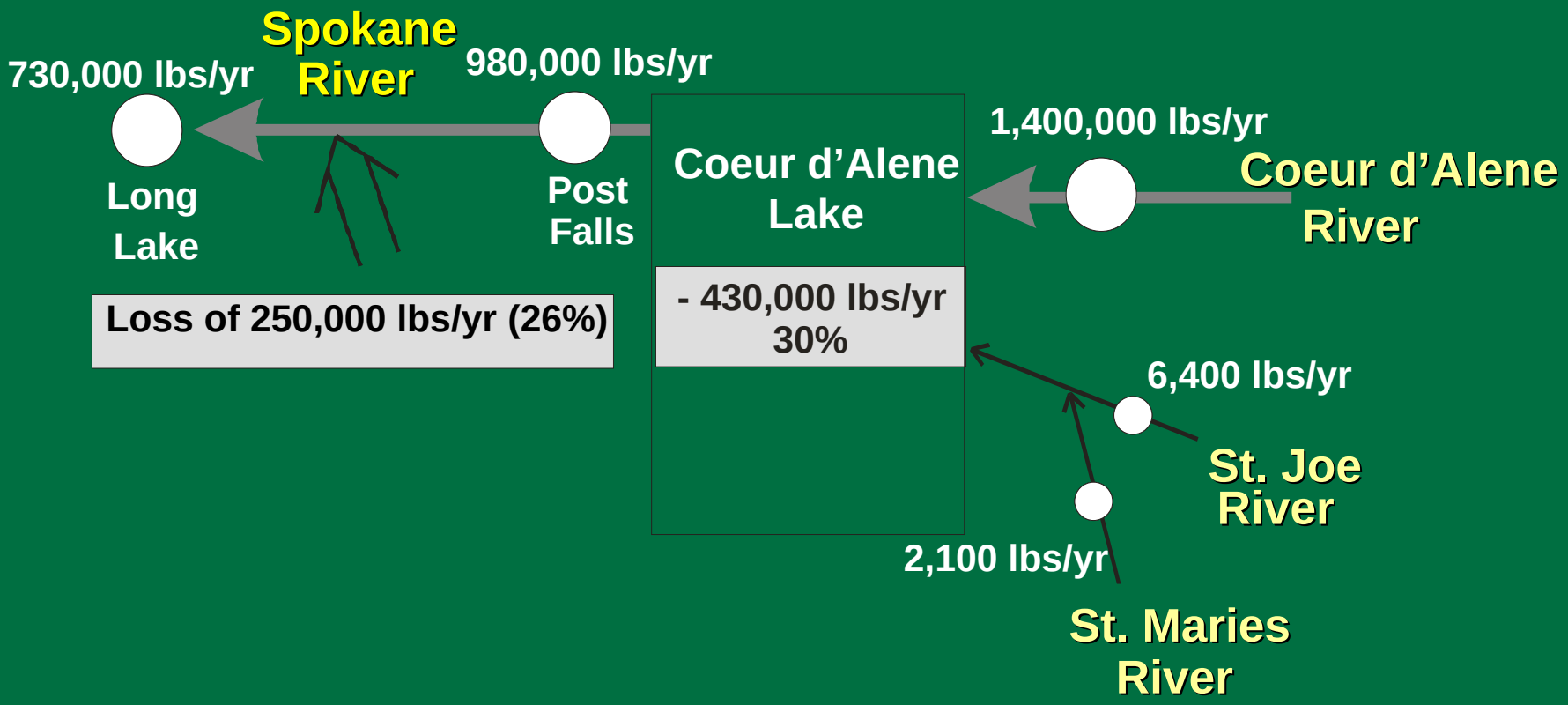
USGS

Spokane River

- Outflow of Coeur d'Alene Lake
- A source of ground-water recharge
- Elevated metal concentrations in river and bed sediment

USGS

Mean Annual Load of Whole-Water Zinc Water Years 1999-2000

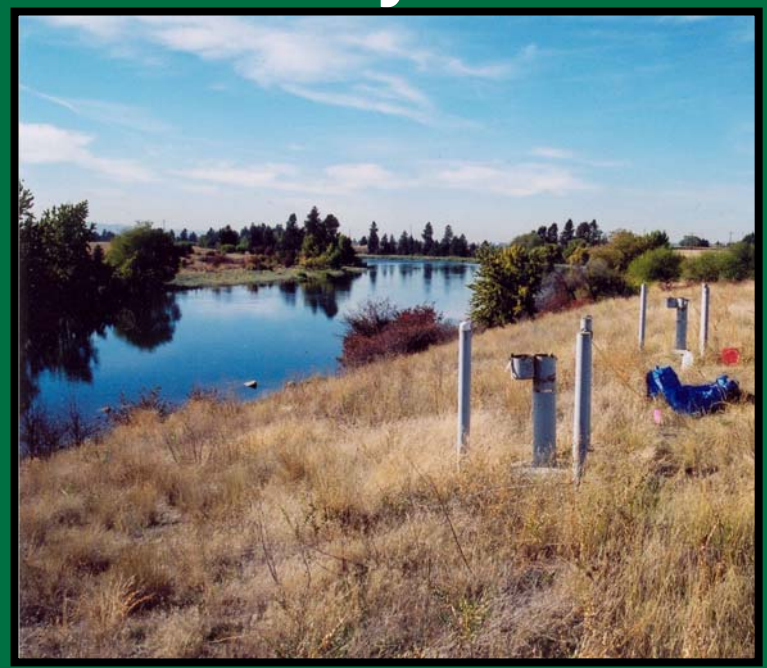


USGS

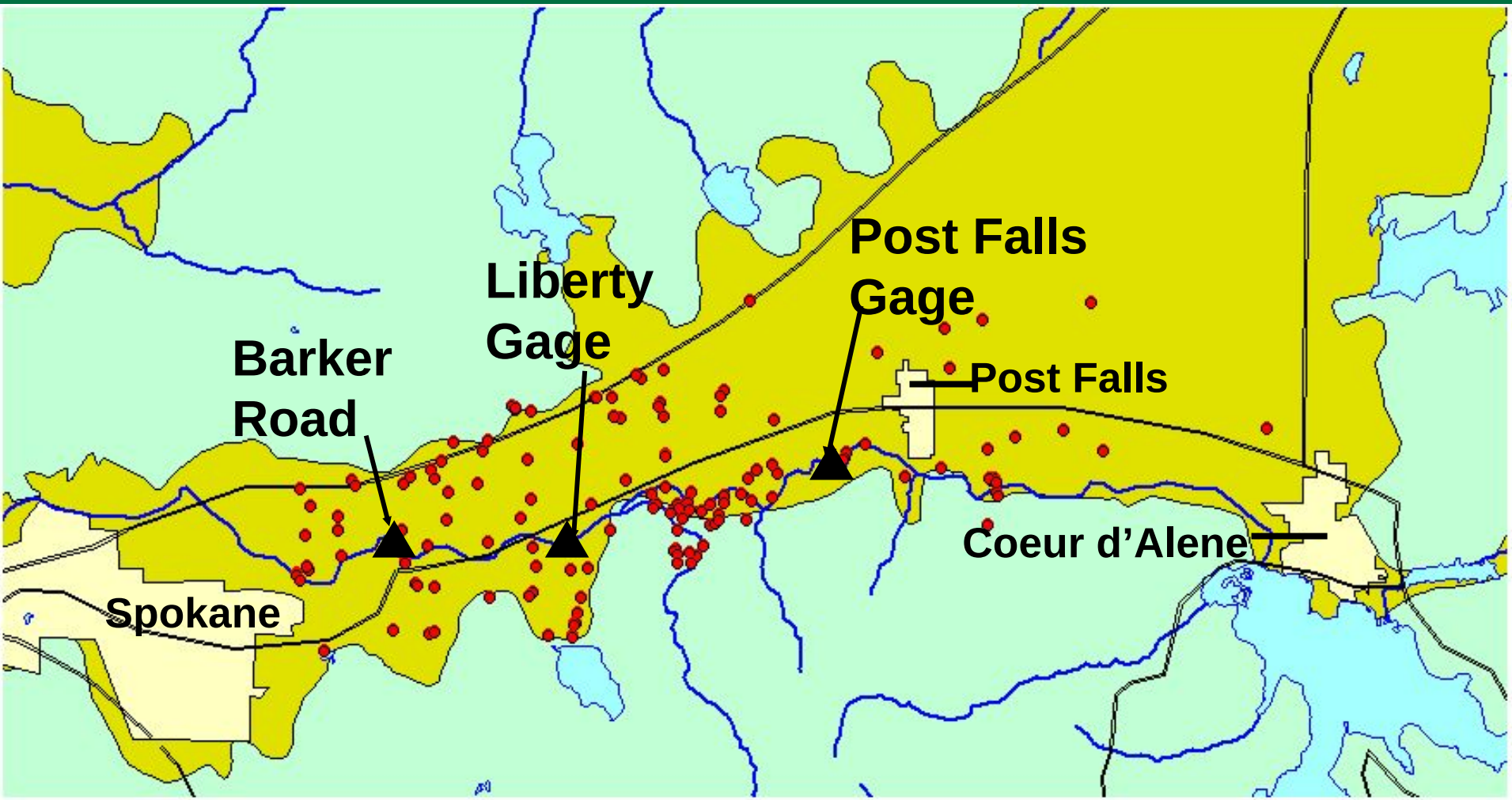
Study Methods

- Streamflow data analysis
- Ground-water level measurement
  - Monthly, synoptic, and continuous

- Water temperature measurement
  - Continuous
- Water chemistry
  - Sample collection and analysis



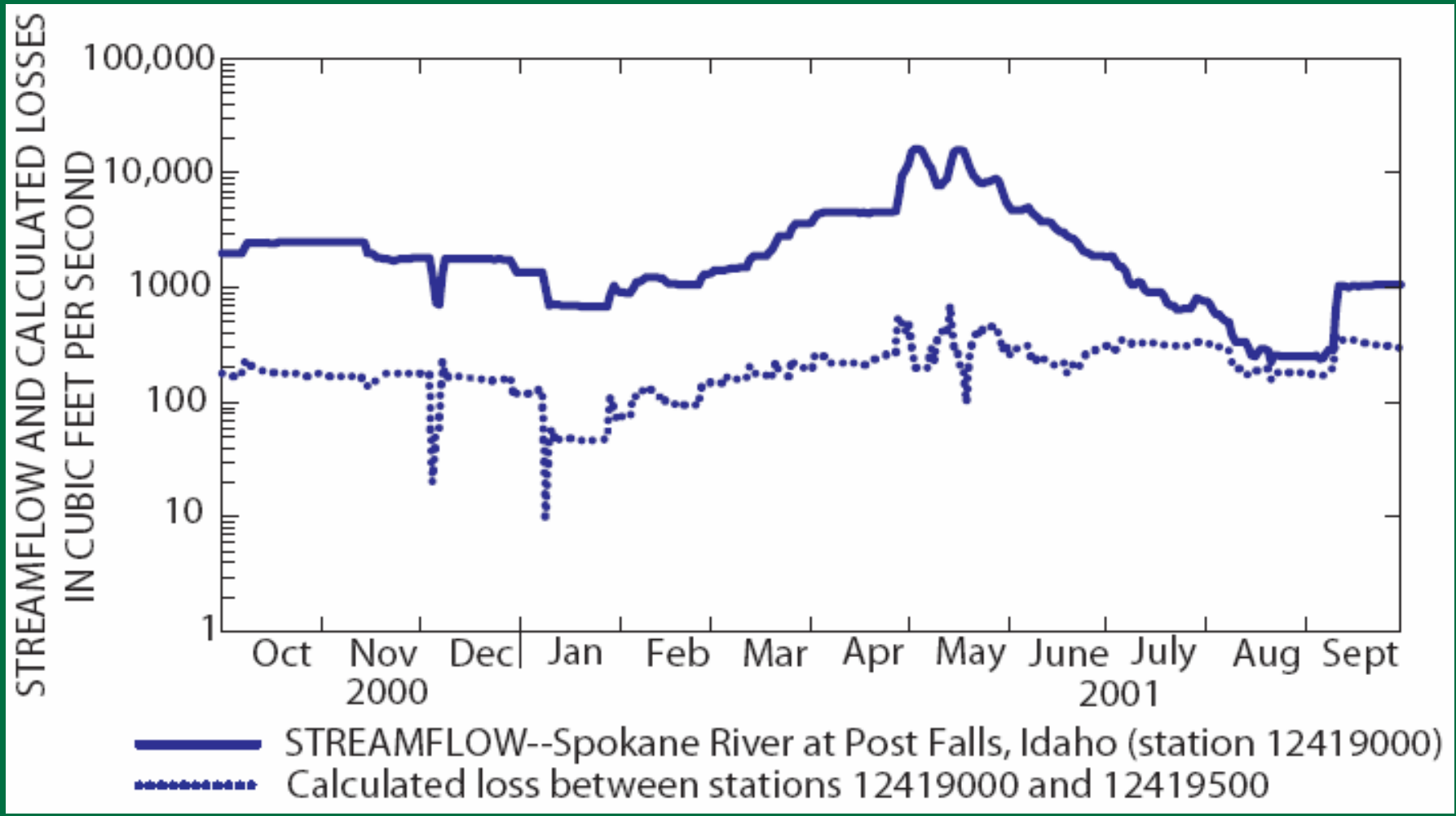
Wells and Gaging Stations



USGS

190 wells

Streamflow and Losses



USGS

Monitoring Network

Post Falls Gage

Spokane Valley – Rathdrum Prairie Aquifer

Post Falls

Spokane

Lynden Road Wells

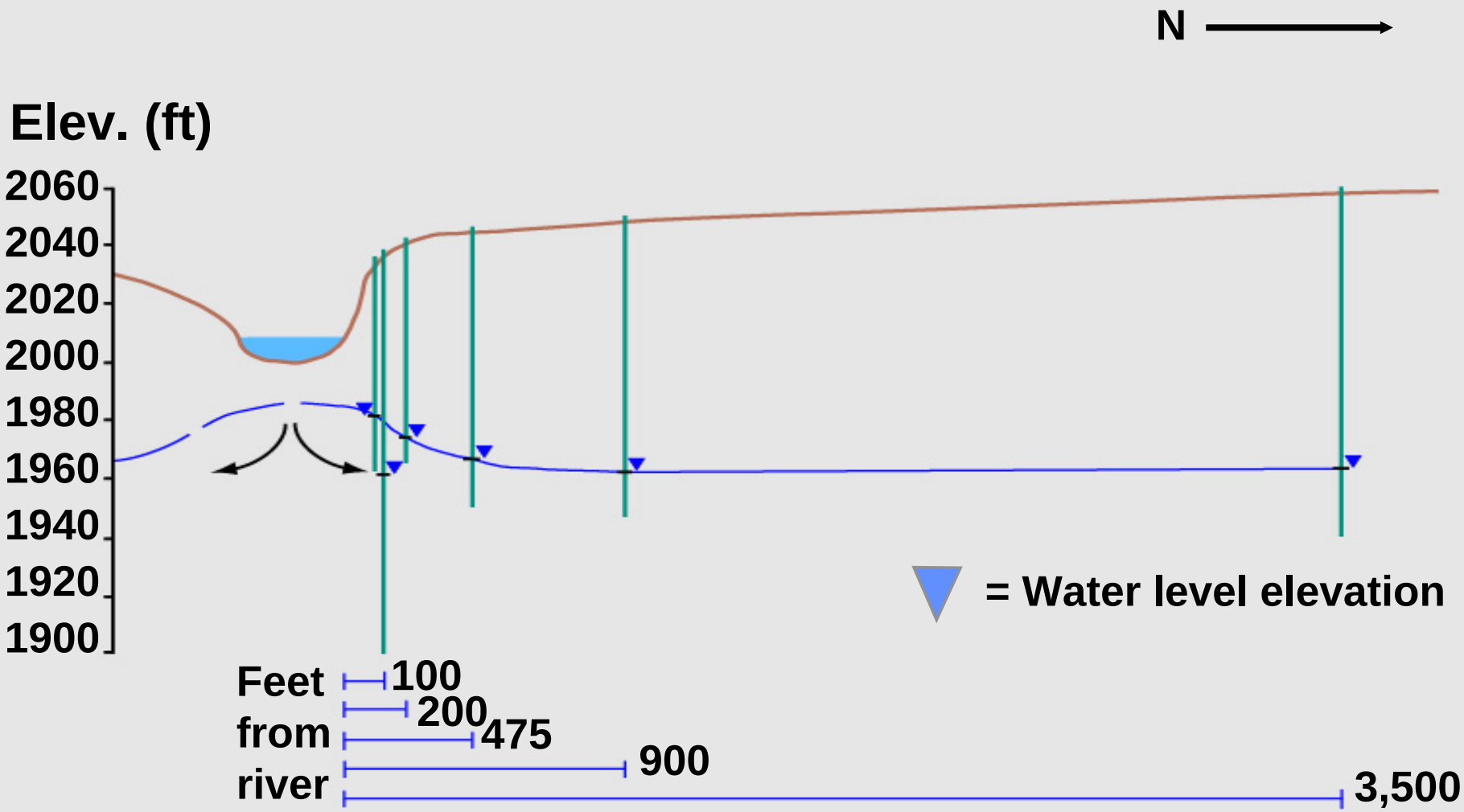
Wells

- USGS (18)
- Pre-existing (7)

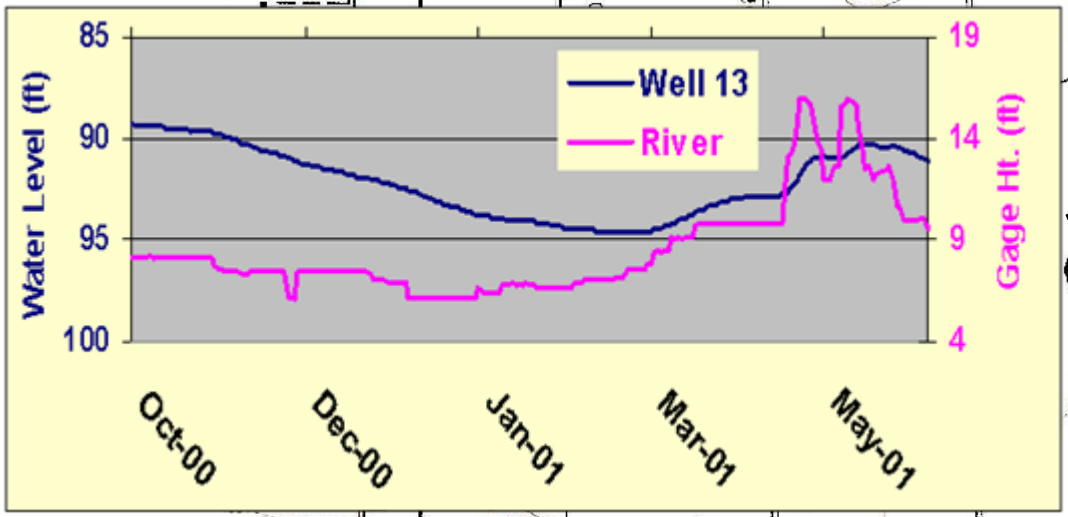
3 0 3 Miles

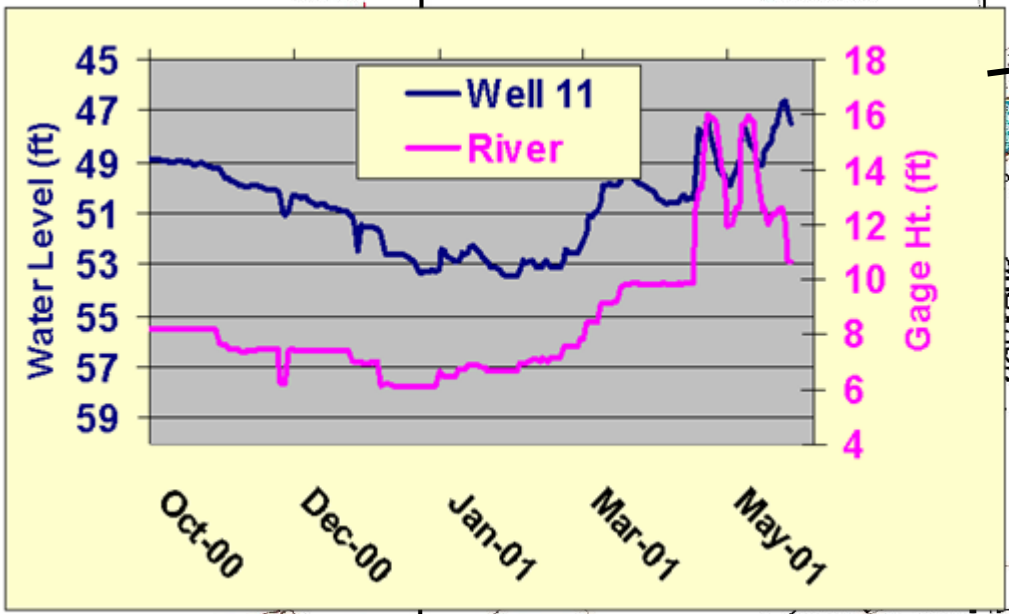
USGS

Lynden Road Wells – Water Levels

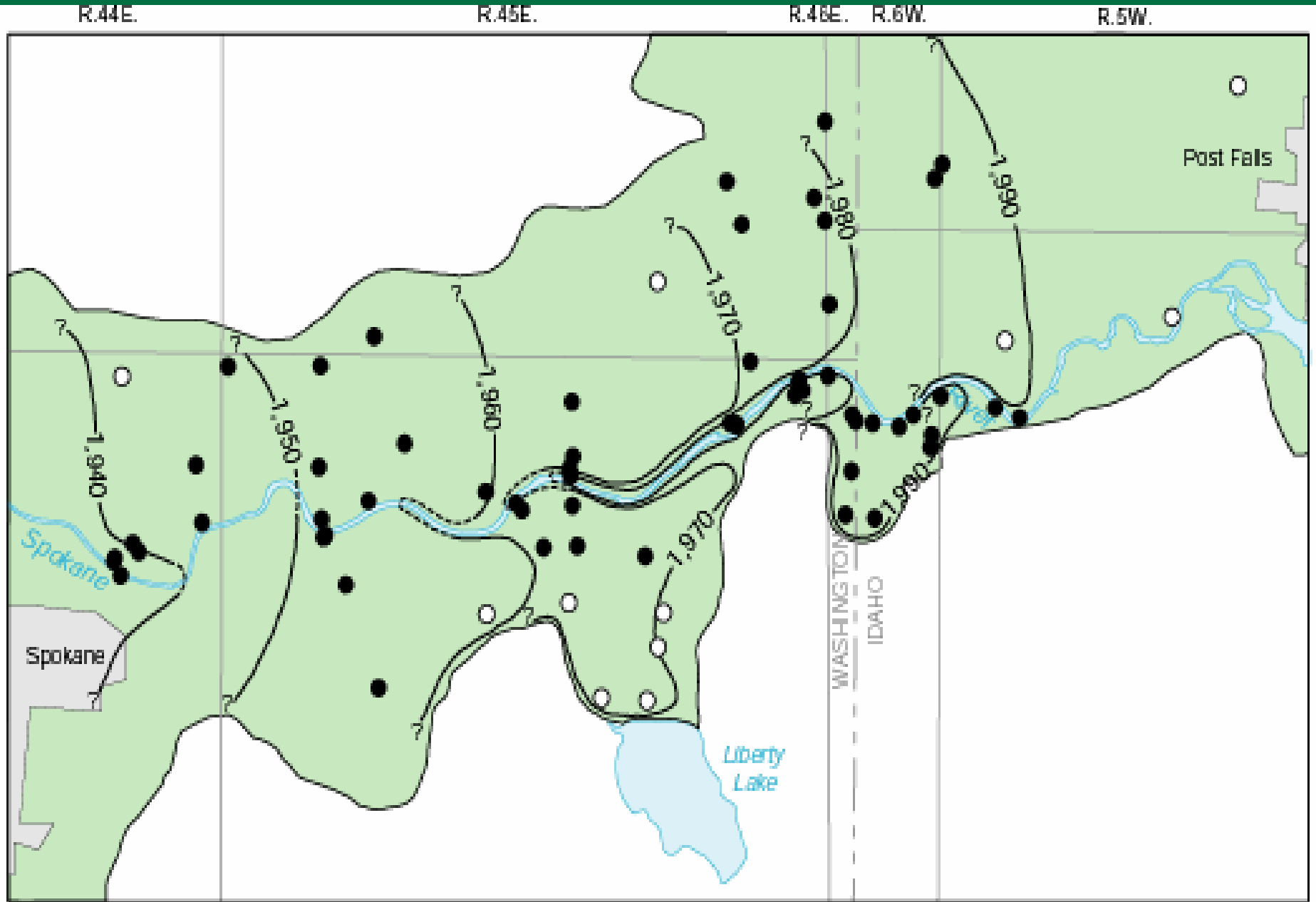


River Stage and Ground-Water Levels





Water Table 8/2000

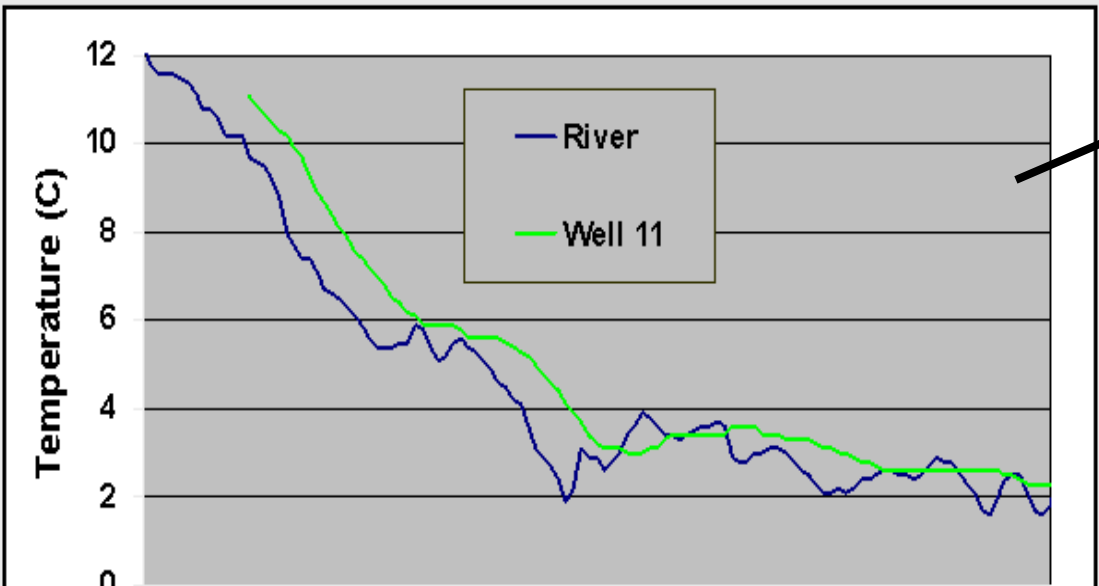


Results: Streamflow and Water Levels

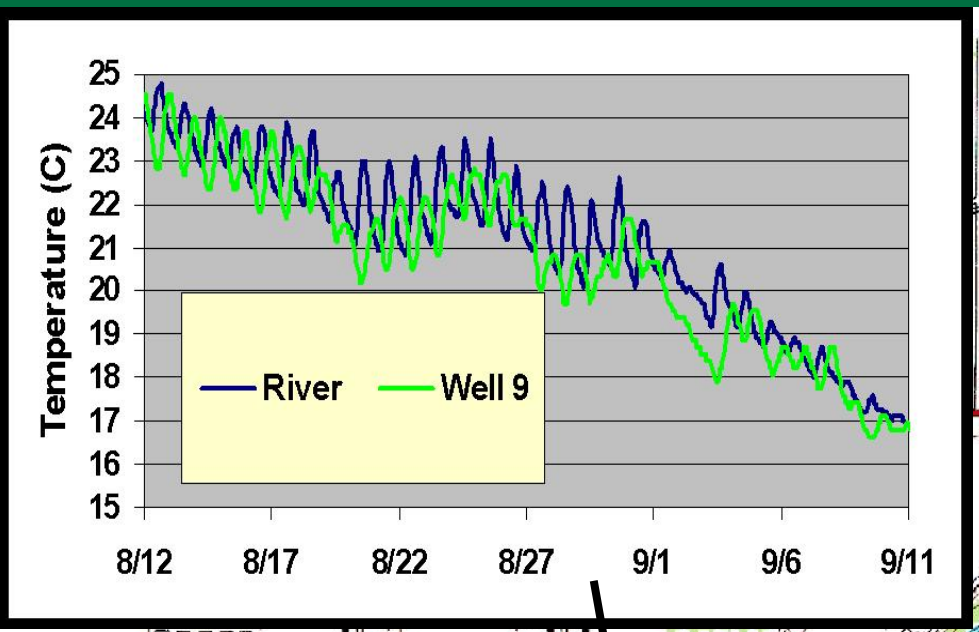
- Delineated a losing reach of the river
- Calculated monthly mean losses ranging from 69 to 810 cfs
- Determined hydraulic gradients to and from the river
- Observed both saturated to unsaturated conditions beneath the river
- Observed that near-river water levels responded to changes in river stage

USGS

Temperature – River and Ground Water

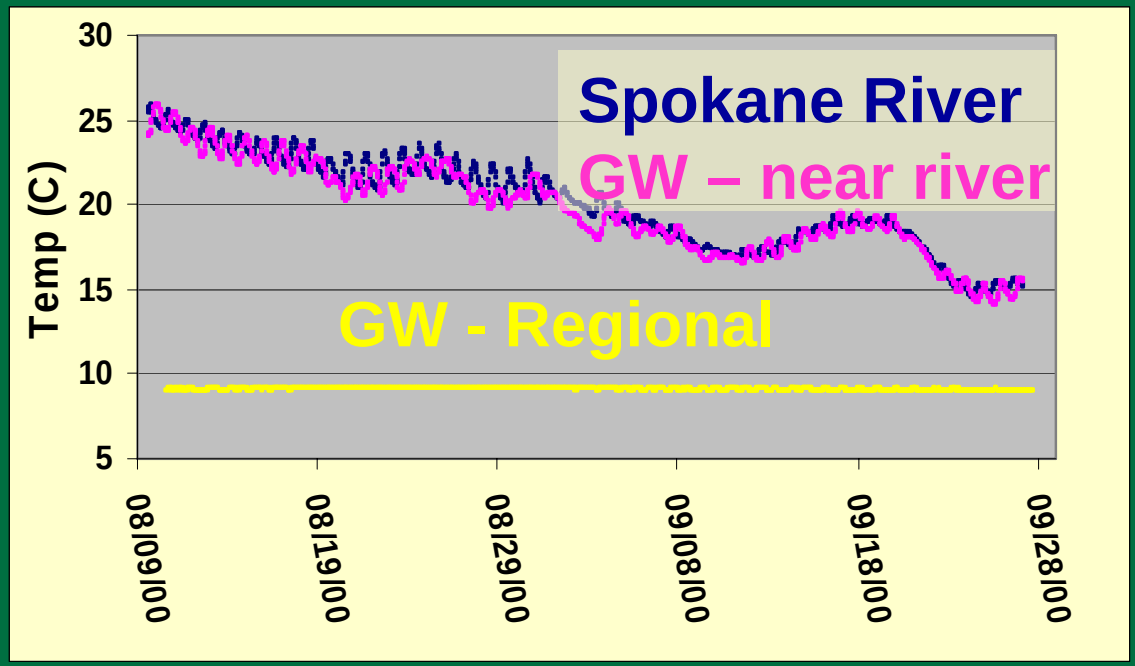


Temperature – River and Ground Water



Results: Temperature

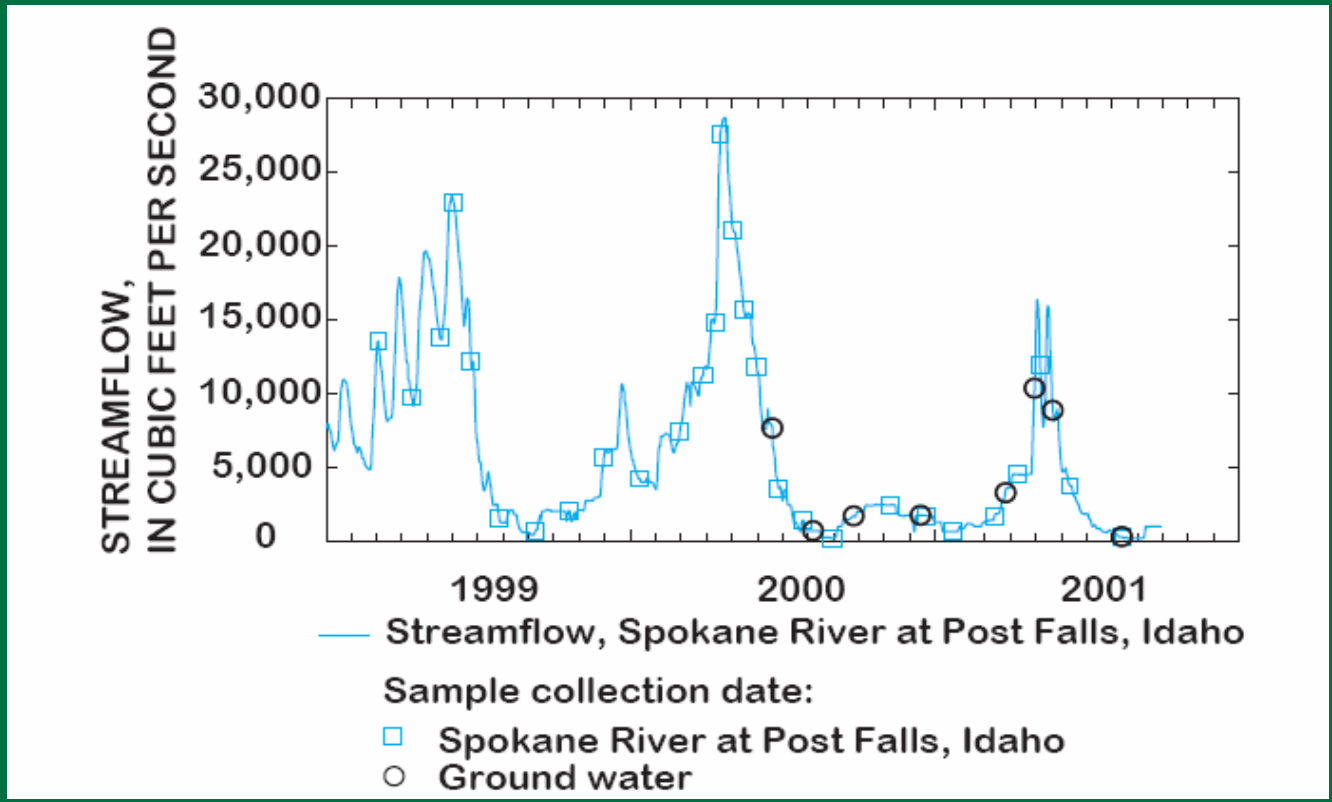
- Indicated areas of ground-water recharge from the river
- Indicated rapid travel time from the river to the near-river groundwater



USGS

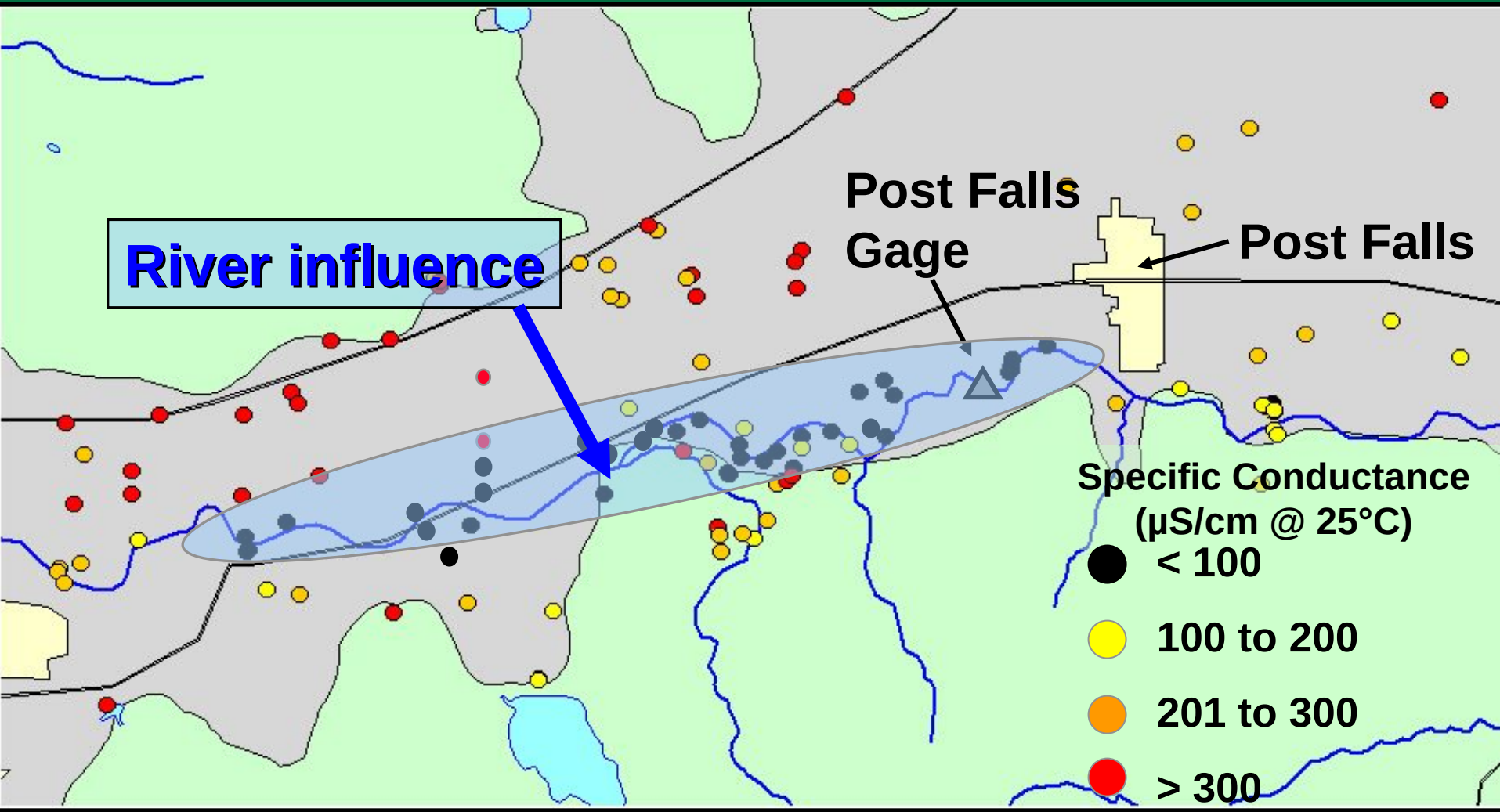
Water Chemistry Sampling

- Analyzed for major ions, trace elements, and stable isotopes
- Examine spatial and temporal variation



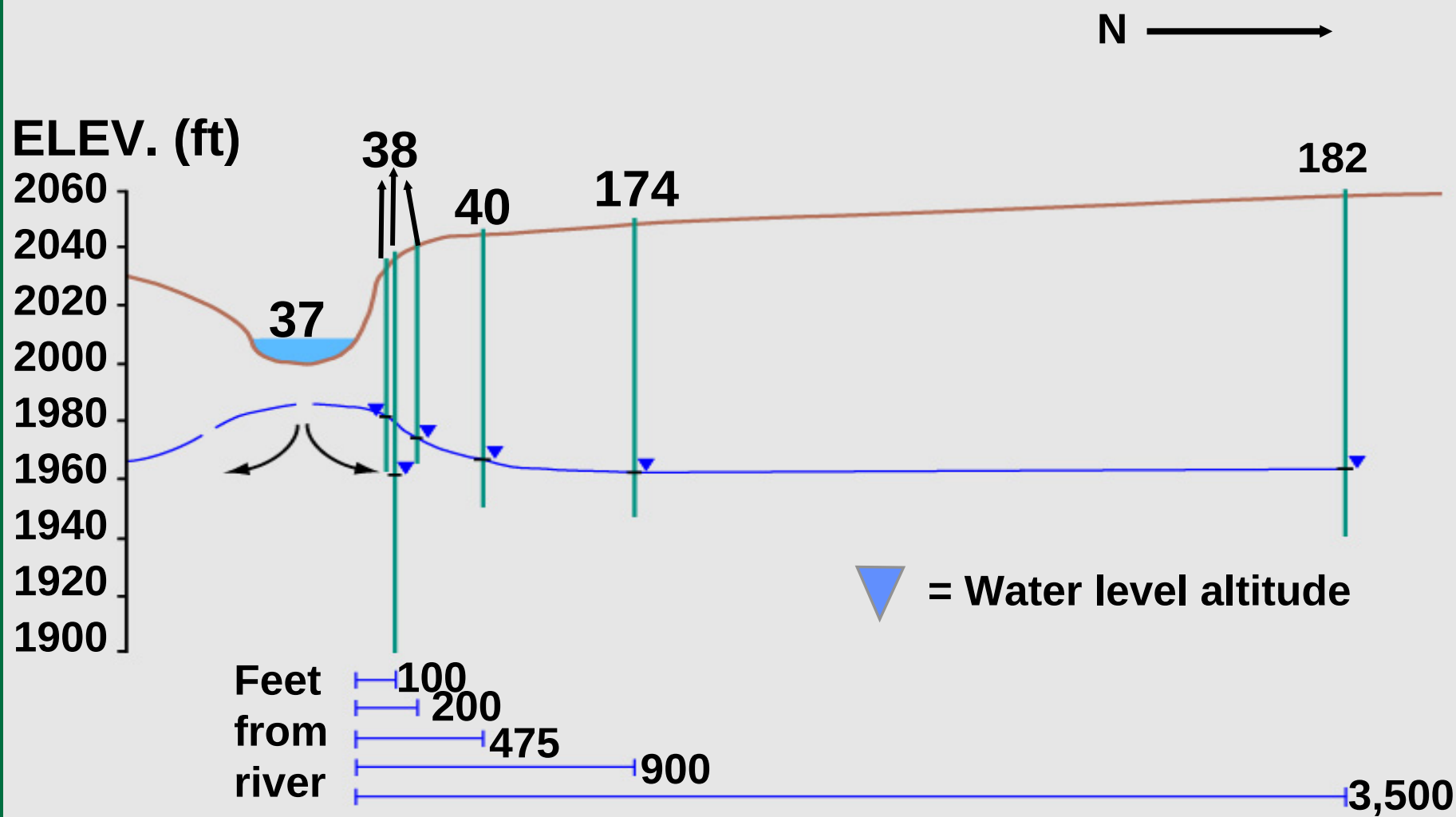
USGS

Specific Conductance

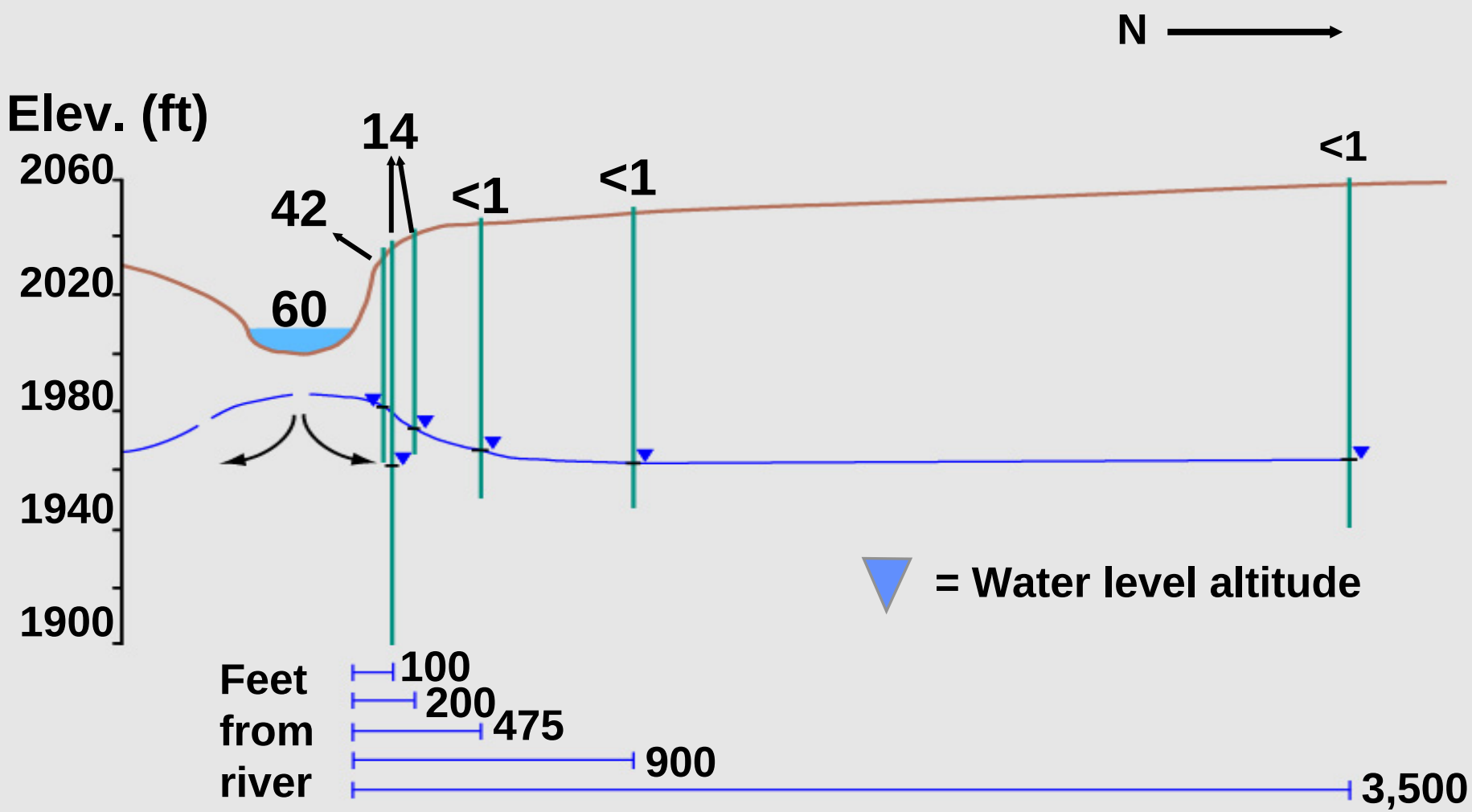


USGS 0 1 2 3 Miles

Median TDS (mg/L) WY 2001



Median Zinc (ug/L) – WY 2001



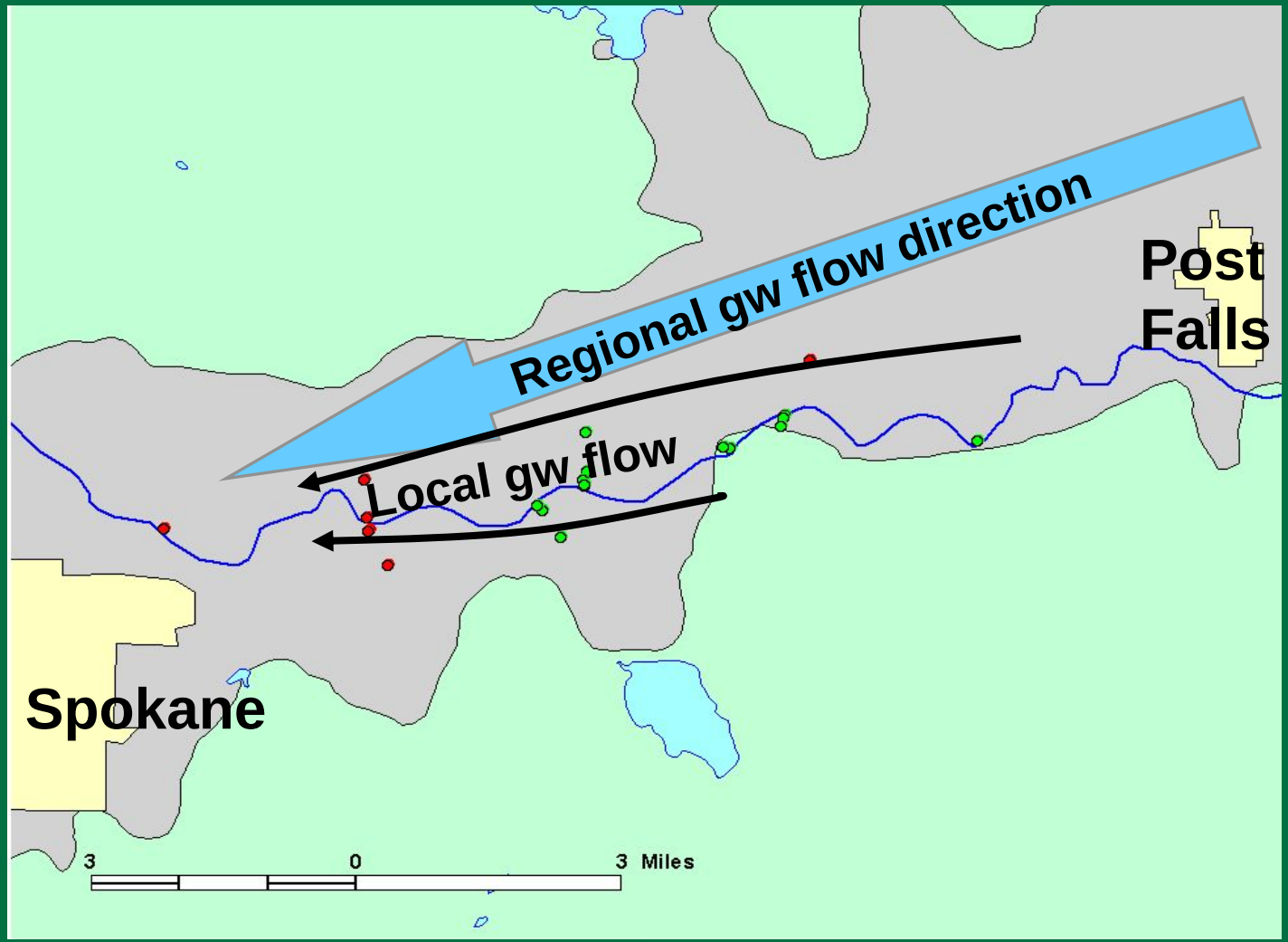
Results: Water Chemistry

- The Spokane River locally influences ground-water chemistry
- Trace-element concentrations were generally lower in the ground water than in the river
- Some constituents (ex. zinc) did not travel as far from the river as others

USGS

Overall Result:

Better understanding of the flow system



USGS

Tools for GW / SW Interaction Studies

- Ground-water levels
  - Discrete measurements
  - Continuous recorders
- Seepage meters
- Streamflow
  - Seepage runs
  - Continuous recorders
- Tracer tests
- **Water temperature**
  - Continuous recorders
  - Thermal imagery
  - Longitudinal surveys
  - Fiber Optics
- Water chemistry
- Modeling

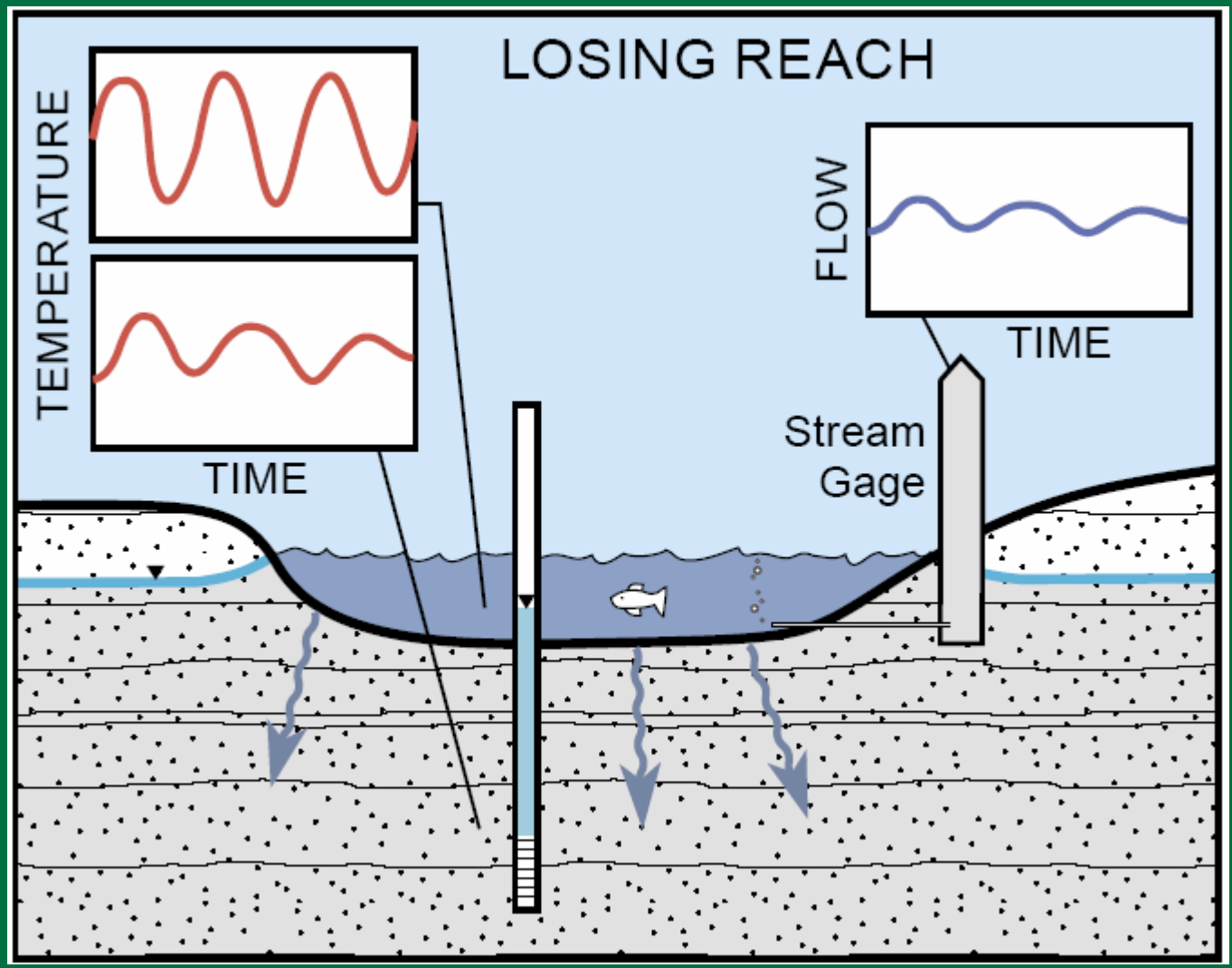
USGS

Why is heat a good tracer for examining ground-water flow near streams?

- Temperature has become an economical and robust parameter to measure in stream and ground-water environments
- Heat is free of real or perceived issues concerning chemical tracers
- Heat and ground-water transport models have become widely accessible

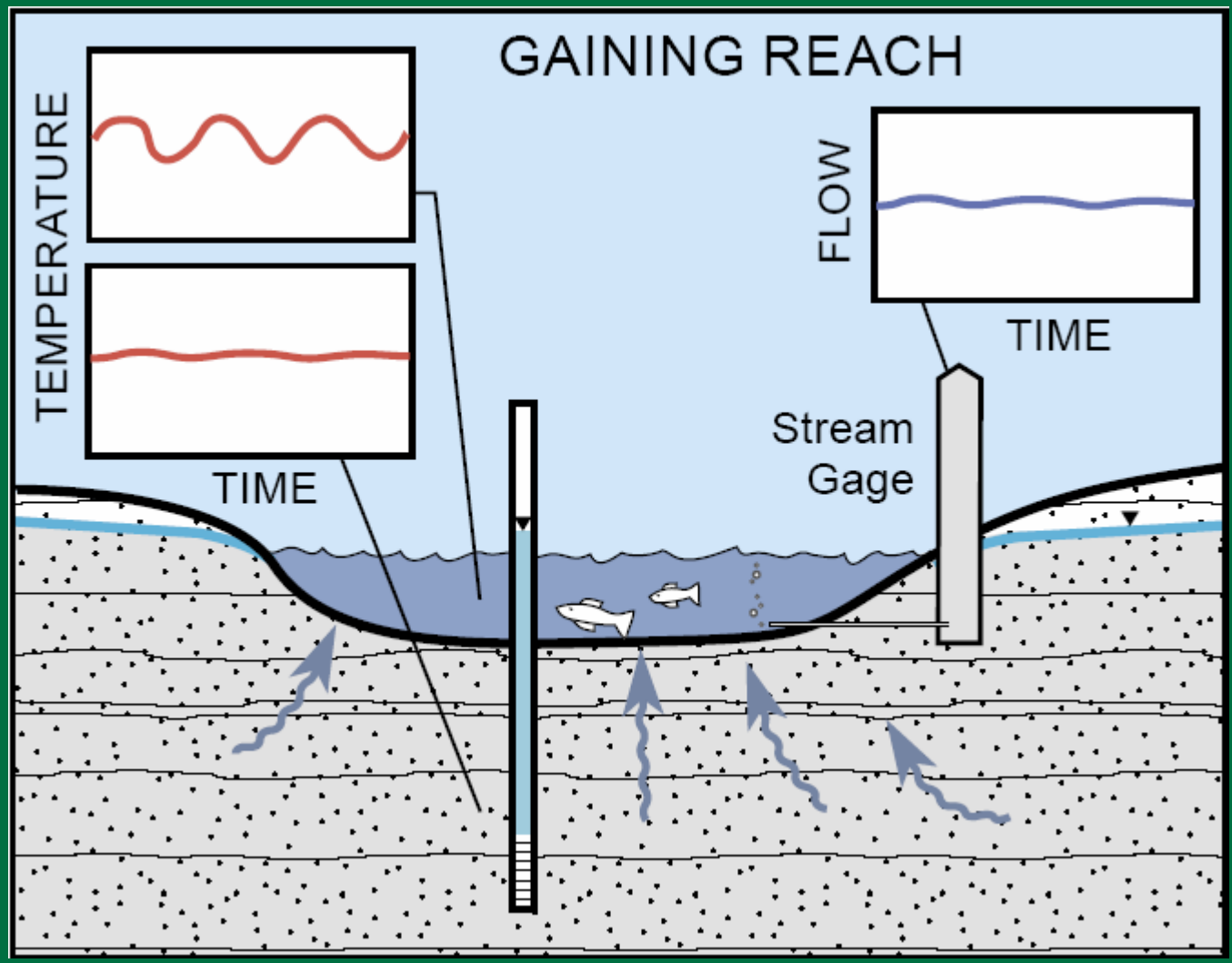
USGS

Temperature - Losing Reach



USGS

Temperature - Gaining Reach



USGS

Methods used in a Hydrologic Investigation of the Smith River Watershed with an Emphasis on Ground-Water / Surface-Water Interaction

U.S. Geological Survey in cooperation with the

Meagher County Conservation District

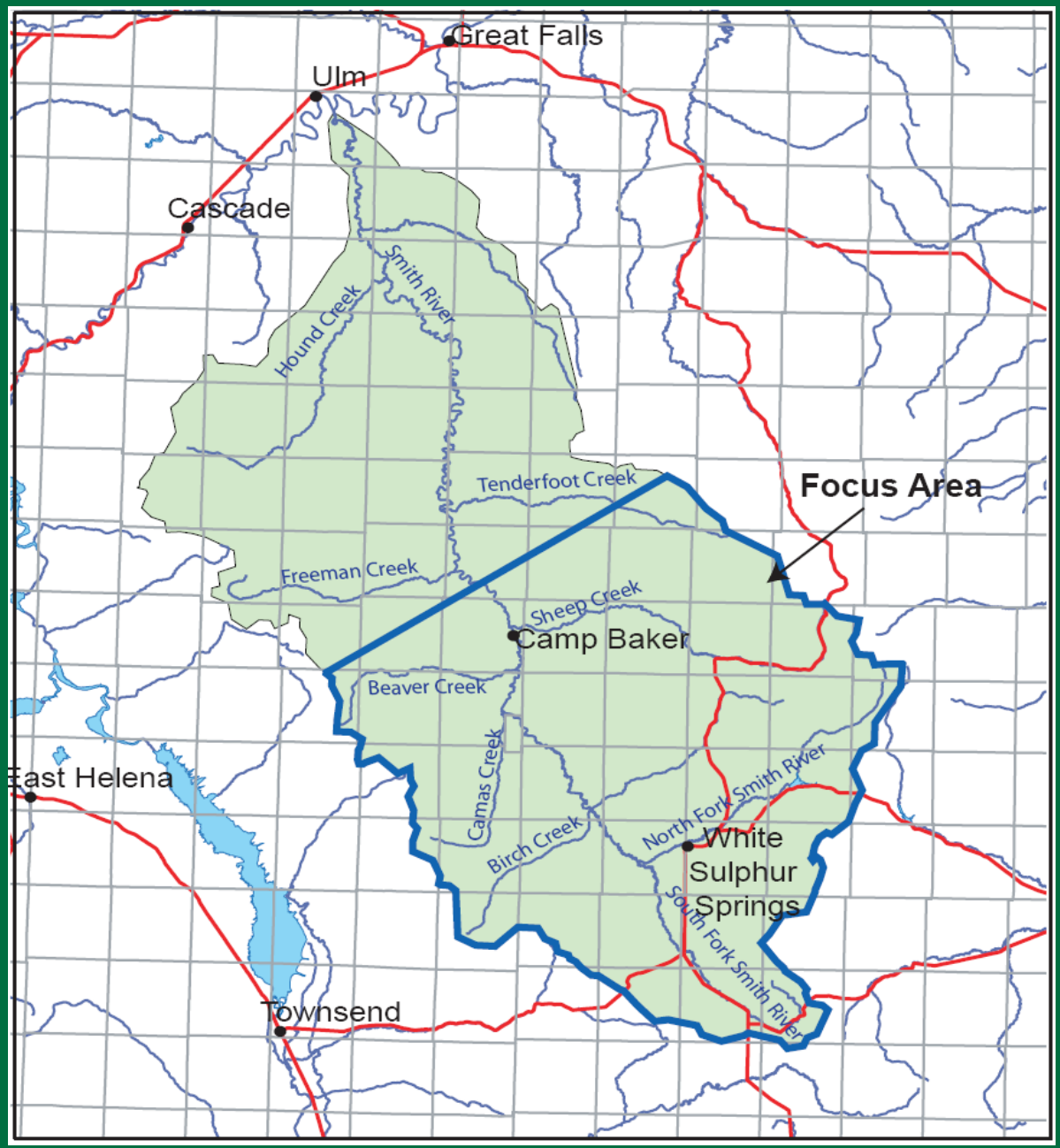
USGS

Objectives

- Increase the understanding of the overall hydrologic system
- Increase the understanding GW/SW interaction
  - Delineate and quantify gaining and losing reaches of the Smith River and its tributaries
  - Determine the hydraulic properties of the streambed

USGS

Smith River Watershed

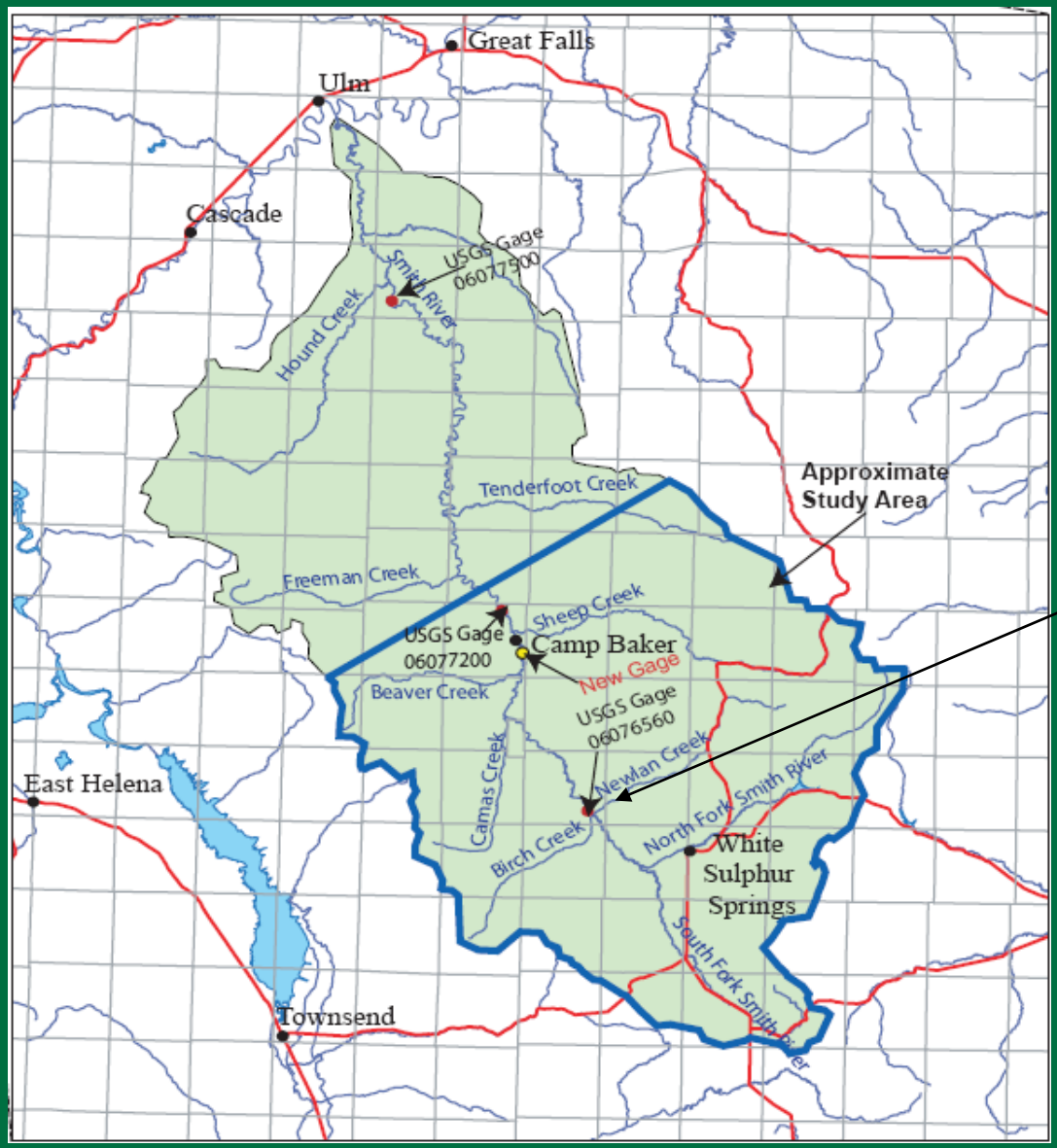


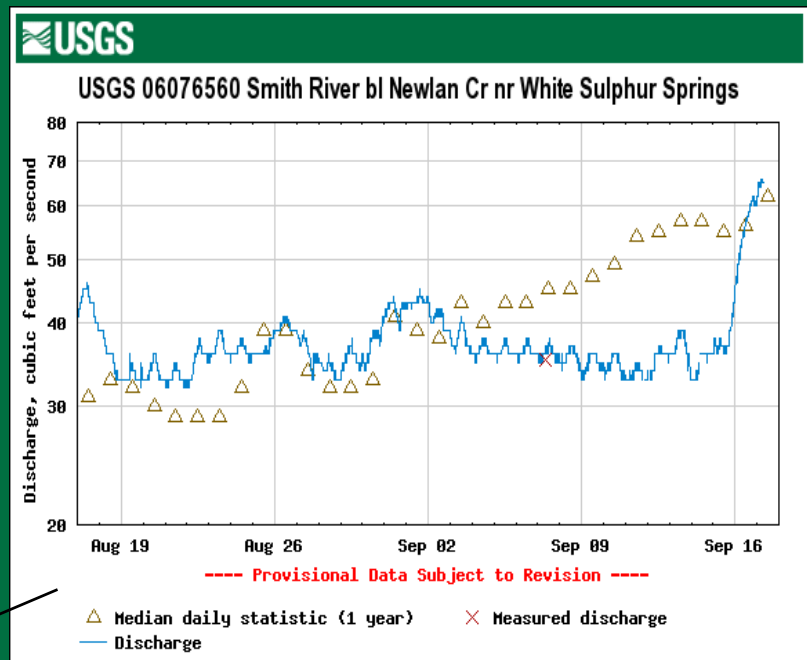
Approach – Multiple Lines of Evidence

- Streamflow measurements
  - Discrete
  - Continuous recorders
  - Seepage runs / synoptic measurements
- Ground-water level measurements
  - Monthly
  - Continuous
  - Synoptic
- Temperature
  - Continuous
  - Longitudinal surveys
  - Thermal Imagery
- Water chemistry
- Modeling

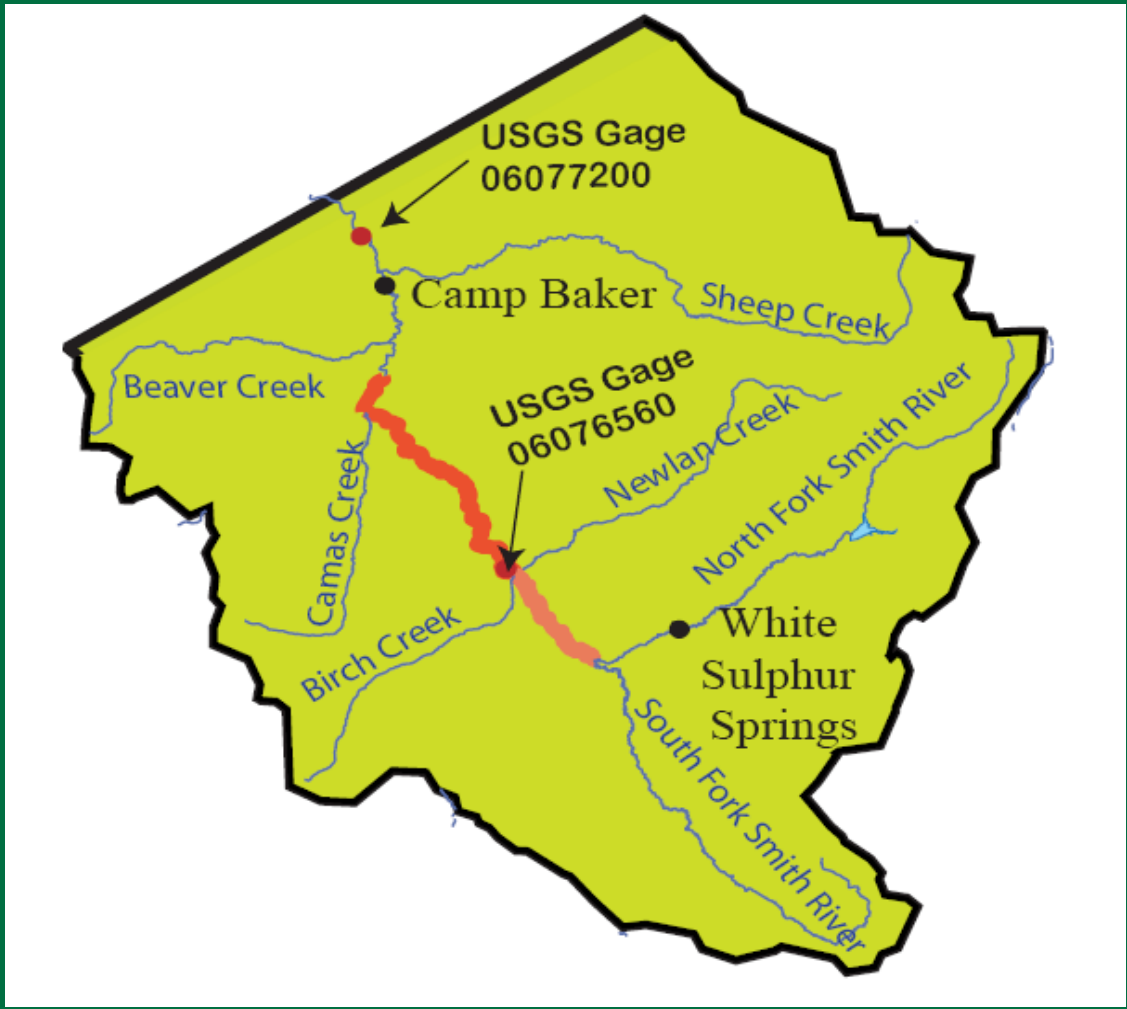
USGS

Gage Streamflow at Four Locations



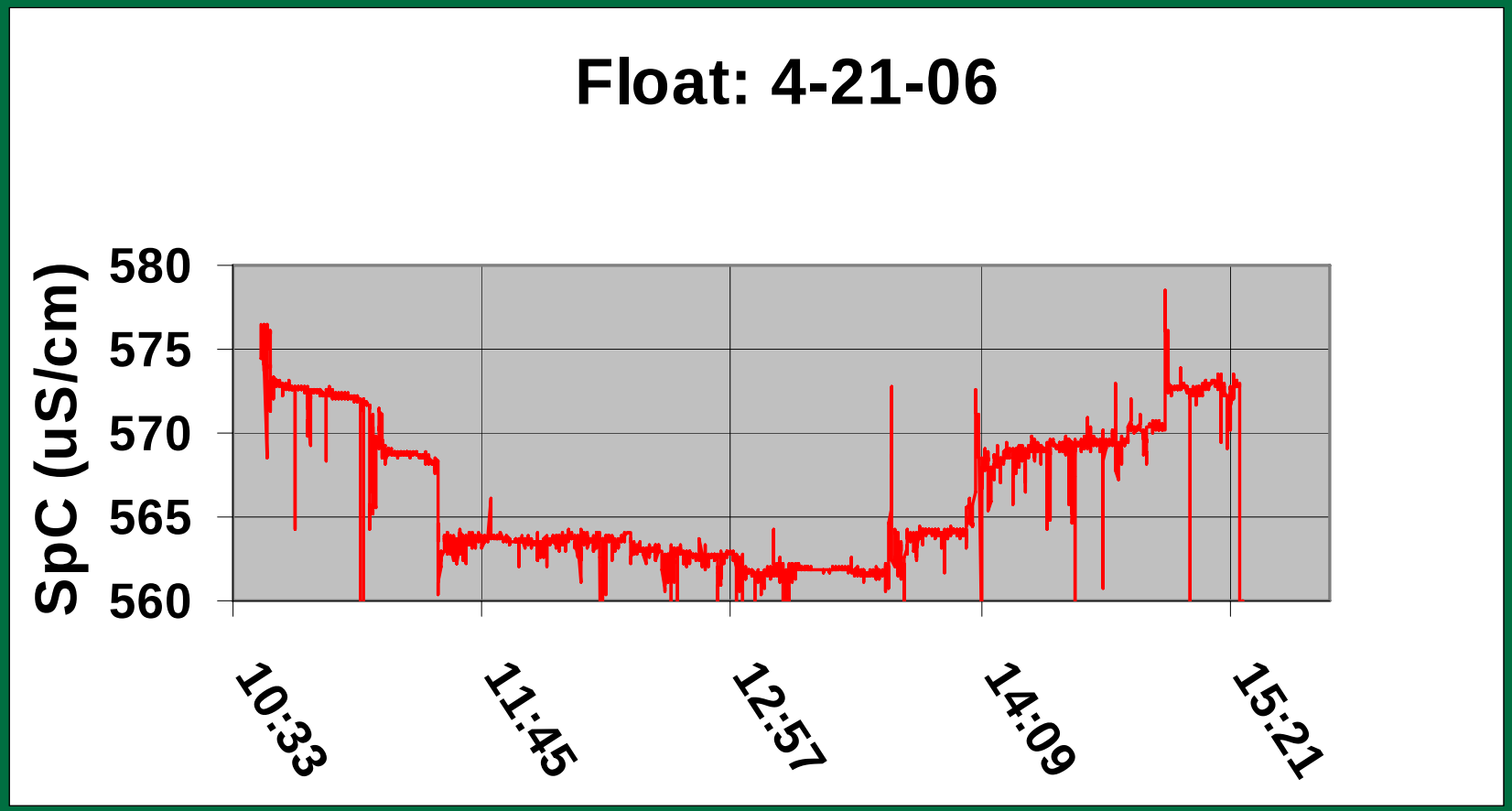


Smith River – Longitudinal Survey



USGS

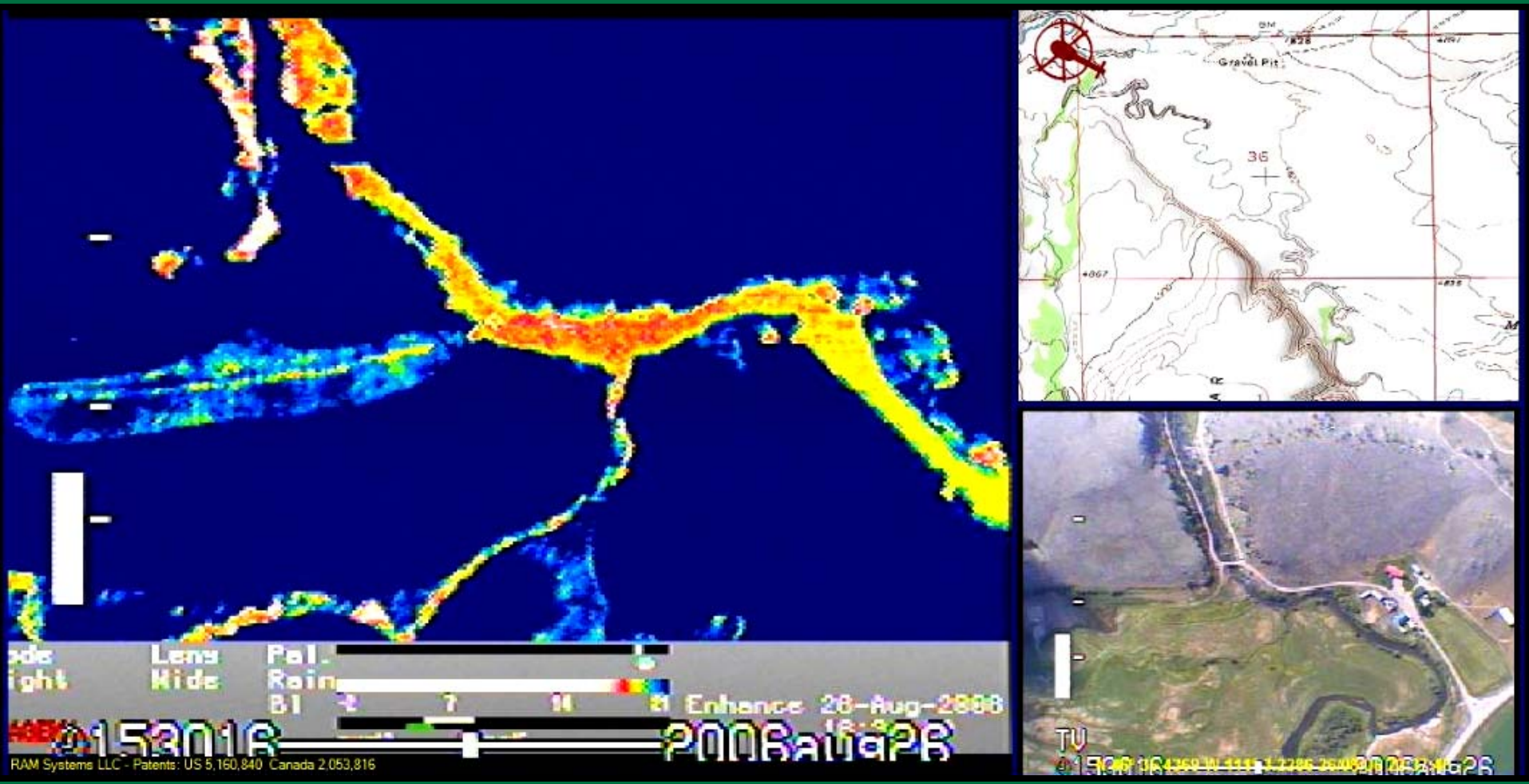
Longitudinal Survey
Specific Conductance



USGS

Thermal Imagery

Thermal Imagery



USGS

Streamflow Synoptic Measurements

- Conducted during various flow conditions
- Flow measured at multiple sites over a short time period
- Inflows and outflows measured
- Differences in streamflow represent gains or losses

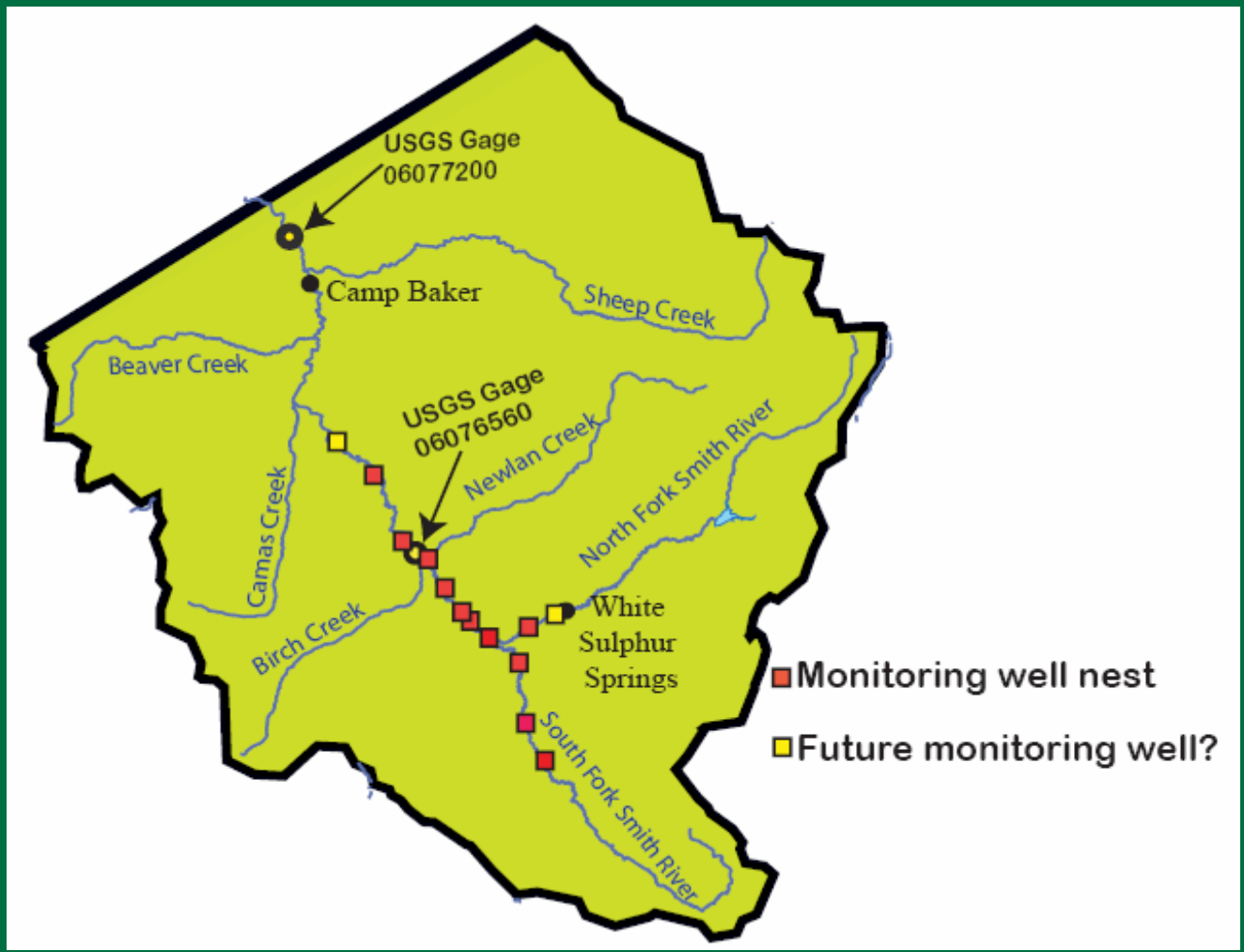
USGS

Synoptic Ground-Water Level Measurements

- Measure water levels in over 100 wells in a short period of time during the streamflow synoptic
- Water-table maps will be produced to represent conditions for each synoptic

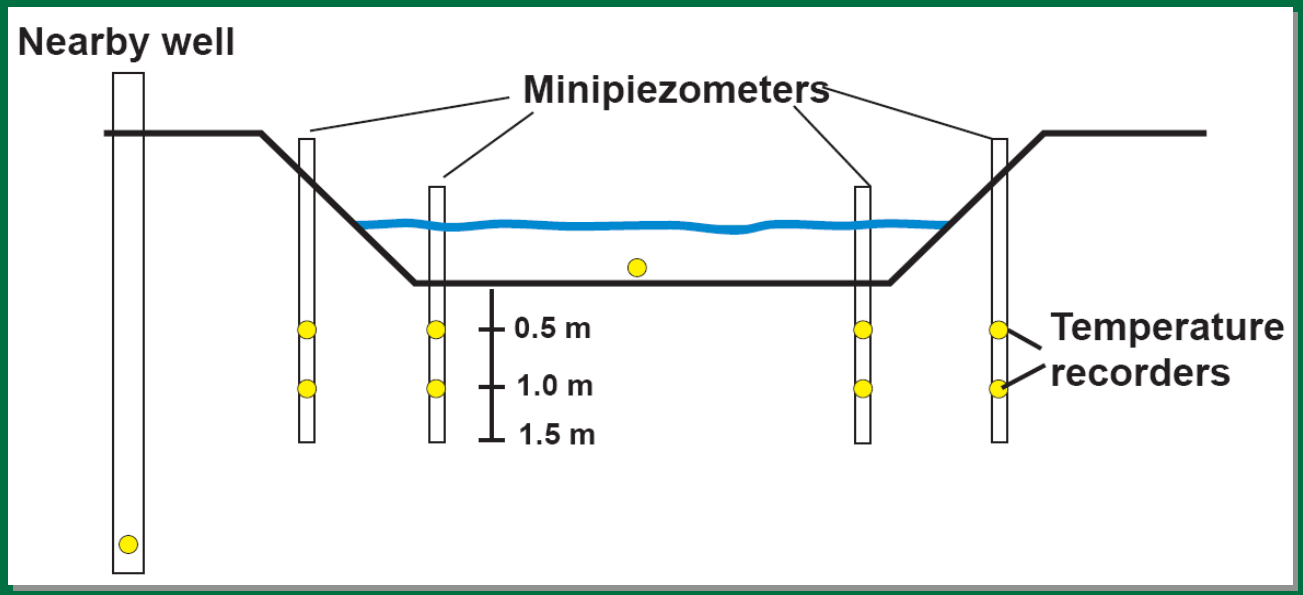
USGS

Monitoring Wells

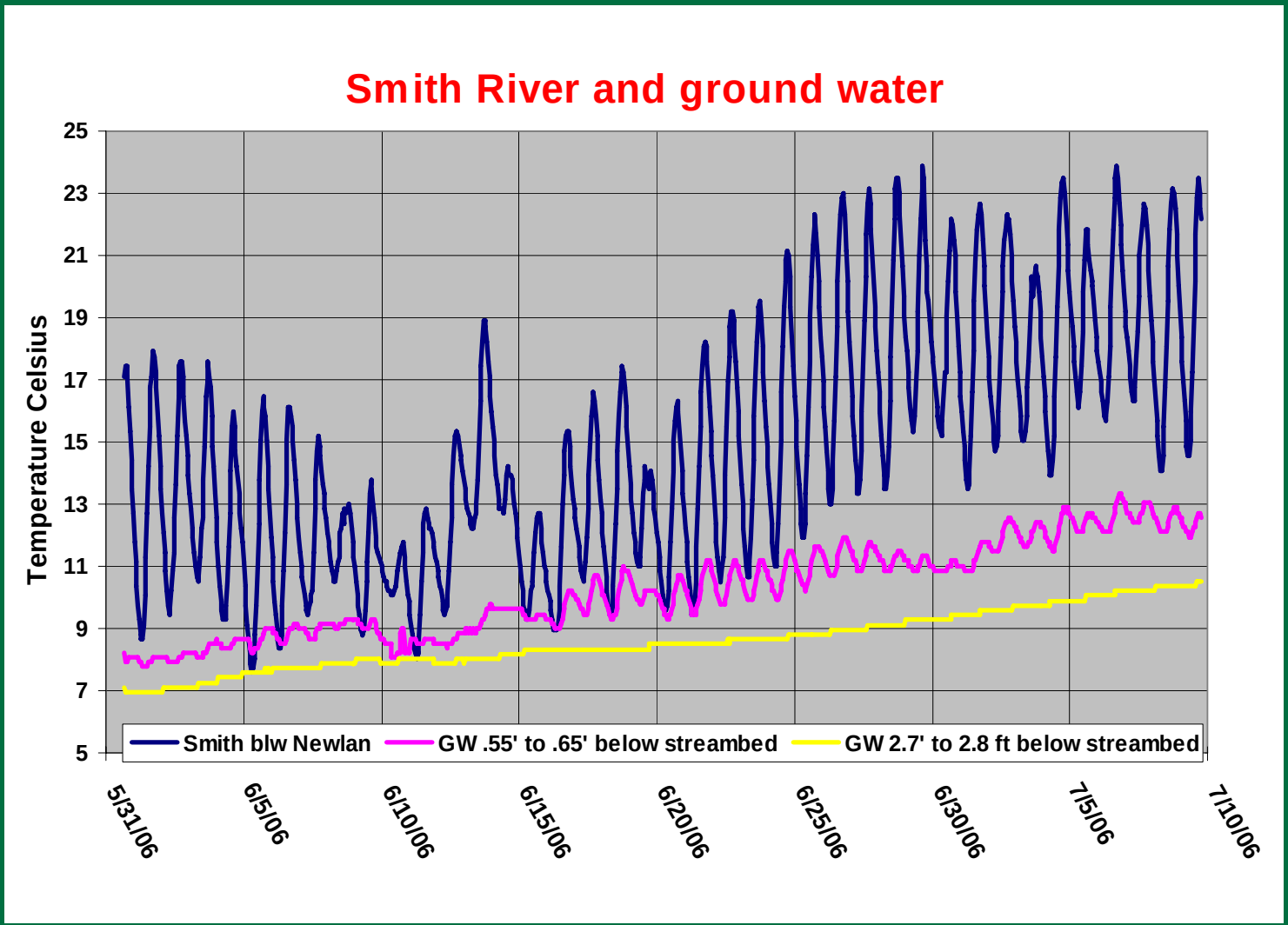


USGS

Temperature and Water-Level Monitoring Network



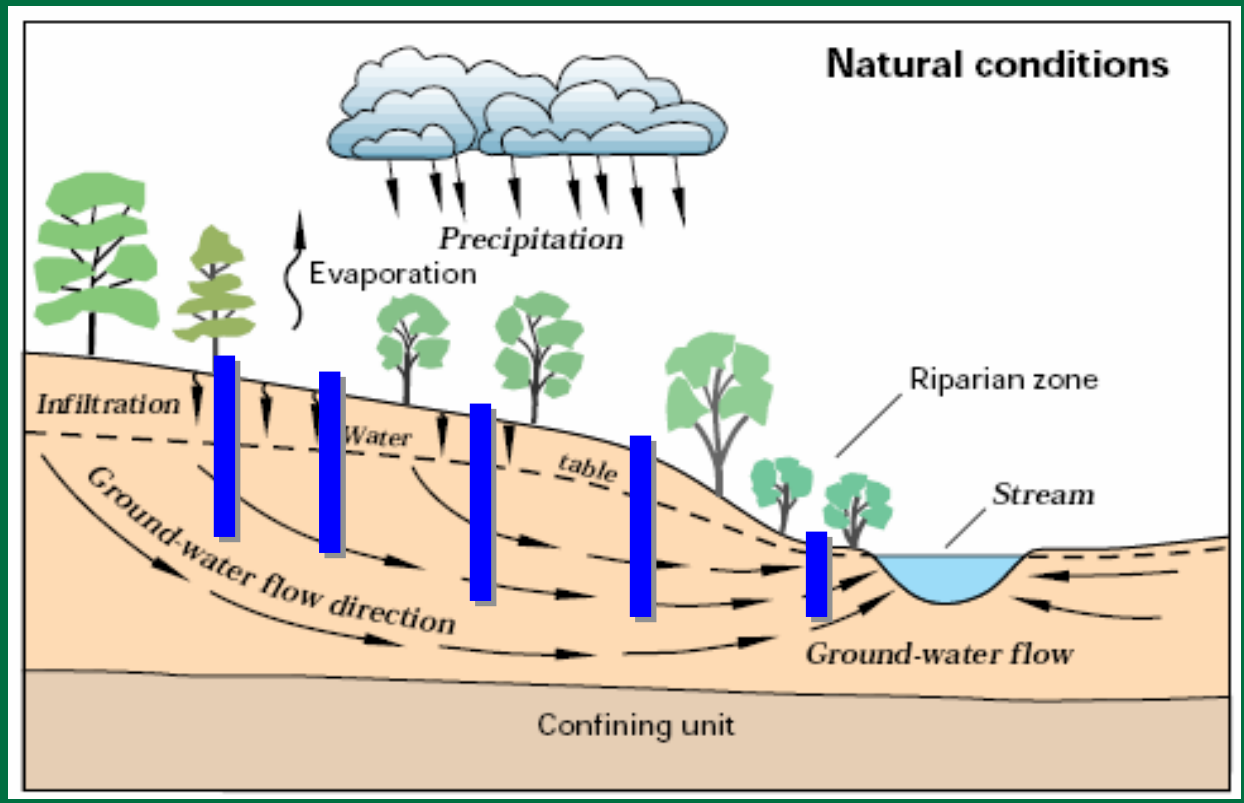
Temperature Profile



USGS

Water Chemistry

- Collect samples from wells along inferred ground-water flowpaths and the Smith River
- Analyze for major ions, trace elements, and other environmental tracers



USGS

USGS